being destroyed); possibly some financial harm to used car dealers; and damage to the livelihoods of people who recycle used auto parts, and who cannot compete with a bonus system to obtain the vehicles they would strip.[7] On the other hand, if industry participants in the program are awarded pollution credits and use them to reduce control costs, this will have some positive effects on the economy.

The Subcommittee on Energy and Power of the House Committee on Energy and Commerce has asked OTA to examine the ability of vehicle scrappage programs to reduce gasoline use and emissions. This report presents the results of a preliminary analysis designed to examine the overall potential of scrappage programs and to determine whether a more detailed analysis would be worthwhile.

SUMMARY

OTA'S analysis indicates that early retirement programs for older vehicles can exhibit a wide range of outcomes, depending on both the structure of the programs and the values of a number of key variables that are very uncertain. However, it is quite likely that a carefully designed early retirement program, targeted at areas that are out of compliance with air quality standards, can achieve environmental benefits at costs equal to or lower than those of other emissions-reduction options that are already in use or scheduled to be used. These programs can also achieve significant gasoline savings as a byproduct, though the monetary benefits of these savings are not counted in our analysis as offsetting to program costs (because the direct benefits accrue to individual owners rather than to society in general, in contrast to benefits associated with emissions reductions). And another byproduct of the programs is likely to be a positive impact on fleet safety, primarily because of the improved safety design of newer cars and the likelihood that the brakes and other safety systems on the vehicles retired will be in worse condition than those on the replacement vehicles.

Policymakers should note that the emission benefits from a vehicle retirement program may decline somewhat in the future. In particular, programs that are delayed past the initiation of reformulated gasoline use (scheduled for 1995) and more stringent inspection and maintenance (I/M) programs required by the Clean Air Act Amendments of 1990 may have reduced emissions benefits. Although the magnitude of the effects is not clear, the use of reformulated gasoline in nonattainment areas is expected to reduce emissions from older cars more than from newer cars, on a grams/mile basis. More stringent I/M programs, with waiver limits (the dollar amount of repair costs which a vehicle owner must spend before continued failure to comply with emission standards will be excused) raised to at least $450, will force more drastic repairs to faulty engines and emission control systems and will cause some of the highest emitting vehicles in the fleet to be retired. Thus, both reformulated gasoline and enhanced I/M programs will reduce the average per *vehicle* emission reductions gained from early retirement. Unless the dolllar value of each ton of emissions reductions rises during this period (this should certainly not be ruled out), the dollar value of emissions benefits will fall. **The numerical results presented in this report do not incorporate the potential effects of these changes.**

Despite OTA's optimism that an early retirement program can be a cost-effective way to control emissions, policymakers should view such a program as essentially experimental in nature. Any such program should be carefully monitored, with random examination of vehicles for operability and emissions performance and followup interviews to determine postsale behavior of participants. Information gained from such a monitoring effort will be invaluable for any future repetition of a nationwide program, and might help jurisdictions that do not participate in the initial wave of programs or that must regulate corporations that seek program entry well after the program begins. Policymakers should also realize that the magnitude of the response to a retirement program is not entirely predictable, so that attracting large numbers of vehicles into retirement may require raising bonus levels (unless bonuses are started at a very high level).

An important side effect of a very large early retirement program will be to increase the demand

[7] Assumming that the vehicles are crushed and melted without being stripped, as in Unocal's program. A retirement program could allow the participating vehicles to be stripped, though this raises a difficult policy tradeoff: Is it better to make the parts available to the market improving the condition of those vehicles remaining in the fleet but probably keeping them operating longer, or to withhold the parts, leading to faster turnover but possibly degrading the condition of the remaining vehicles?

Table l—Benefits and Costs of Vehicle Scrappage Program Retiring 1 Million Vehicles (baseline scenarios)

Model years in program	costs,[a] ($million/ year)	Emission reduction (1,000 tons/year) HC	CO	NO_x	Gasoline savings (million gallons/ year)	Emission benefits[b] ($million/year)	Cost/benefit[c] ratio
Method 1 (assumes all miles replaced by miles in new cars)							
Pre-1970	221 to 312	63	343	13.5	171	366	.60 to .85
Pre-1975	209 to 266	57	327	15.0	213	354	.59 to .75
Pre-1980	279 to 368	51	400	16.0	142	346	.81 to 1.06
Method 2 (assumes miles replaced by existing fleet (half) and new cars (half))							
Pre-1971	258	59.5	448	16.5	182	365	.71
Pre-1980	369	44.0	369	16.5	135	294	1.26

[a]Excludes administrative costs. Assumes 10 percent interest rate, $700/vehicle bonus for pre-1 970/71 and pre-1 975 cars., $1,000/vehicle bonus for pre-1980/81 cars.
[b]HC valued at $3,050/ton, NO_x at $2,750/ton, and CO at $300/ton.
[c]Includes emissions benefits only.

SOURCE: Office of Technology Assessment.

for, and raise the prices of, the remaining cars in the fleet, because many of the former owners of the retired vehicles will seek to purchase replacement vehicles. This will adversely affect lower income vehicle buyers just entering the car market. On the other hand, the money used to purchase the vehicles will go directly to former owners of the retired vehicles, many of whom may be expected to be of lower income.

As discussed below, estimated benefits of a vehicle scrappage program cannot be calculated with precision, not only because of uncertainty about such a program's physical effects, but also because there is no consensus about the monetary value of emission reductions. Without a basis for directly valuing these reductions, we are here measuring emissions benefits only in the sense of how much it would cost to use other available control measures, for example, alternative fuels. Under a baseline set of assumptions and valuing emission reductions at levels suggested by the Environmental Protection Agency (EPA), calculated emissions benefits[8] for a program targeted at nonattainment areas would exceed program costs if either pre-1970 or pre-1975 vehicles were targeted (assuming a $700/vehicle **bounty); if pre-1980 vehicles were targeted (with a $1,000/vehicle bounty), the estimated benefits range from higher than to lower than the estimated costs, so cost-effectiveness is not assured.** Table 1 displays the annual costs and benefits of the baseline cases, using two calculation methods. *Note again that calculated costs and benefits do not include the value of gasoline savings, part of which is a private savings and part a difficult-to-quantify national security benefit; monetary benefits associated with increased new car sales; and costs associated with any lost mobility for poor workers.* **If we valued the public benefits of gasoline savings (lower oil imports, improved energy security) at 50 cents per gallon or higher, total benefits would equal or exceed costs in all cases examined.**

As an example, assuming that the ''make up' miles replacing the miles lost on early retirement are split equally between miles in new vehicles and increased driving in the existing fleet, we calculate that retiring 1 million vehicles of pre-1971 vintage would cost $.75 billion (assuming a $700/vehicle bonus and a $50/vehicle administrative cost) and yield annual emission reductions of about 60,000 tons of HC, 448,000 tons of CO, and 17,000 tons of NO_x. These emissions reductions, if achieved in nonattainment areas, would be ''worth" about $1 billion[9] over the approximately 3 year period during which the average retired vehicle would instead have been operating.[10] Gasoline savings would be about

8 We are measuring emissions "benefits' here in an extremely limited fashion, that is, by assuming that the benefits of removing a ton of pollutant are approximately equal to the cost of the more expensive measures that are being taken to control that pollutant. Actual benefits, measured as the social value (in terms of lower rates of sickness and fatality, improved recreational values, lower rates of property damage from pollution, and so forth) of reducing emissions, may in reality be considerably different from these control costs.

9 According t. an EPA valuation of emissions reduction benefits.

10 Assuming a 10 percent discount rate.

Table 2—Effects on Emissions Benefits of Changes in Policies, Assumptions

Change in policy	*Effect on emissions benefits*
1. Select pre-1971 rather than pre-1980	Up 22 to 36 percent
2. Wait until tier 1 standards take effect	Up 4 to 5 percent
3. Retire only vehicles with higher-than-average emissions	Up 100 percent or more
Change in assumption	
4. Retired cars would have lasted 4 rather than 3 years	Up 27 percent
5. Miles actually replaced by half new cars/half existing cars rather than all existing cars	Up 12 to 23 percent

SOURCE: Office of Technology Assessment.

182 million gallons per year, or about 12,000 barrels per day.[11]

The generally favorable cost-effectiveness of early retirement programs in nonattainment areas does not apply to programs in areas complying with air quality standards. The Clean Air Act does not require attainment areas to add new control measures beyond those already in place or to be added on a nationwide basis, so that the true "avoided control cost' '-based emissions benefits are zero in these areas. We note, however, that the national ambient standards may not fully protect the public from some chronic health effects of long-term exposure to ozone, or fully protect public welfare (e.g., crop and material damages) and the natural environment.

The above values depend critically on *assumptions.* For example, we cannot be sure what types of vehicles will be attracted to a large-scale scrappage program, particularly their emissions levels and the extent to which they would have been ready for retirement anyway, or else would have been kept operative but used much less than average vehicles. **If our assumed values for the emissions and remaining lifetimes of the vehicles in the program are too high (or too low), then the benefits have been overstated (or understated).** Although the vehicles attracted to Unocal's pilot program generally were relatively high emitters and appeared to be in active use and have substantial lifetimes remaining (implying large emission and oil conservation benefits from early retirement), we remain concerned about the possibility that some programs might attract many vehicles that would otherwise be little **used (implying low emission and conservation benefits). On the** other hand, the evidence of in-use measurements of vehicle emissions tends to show that emissions estimates based on MOBILE4, the model used in this analysis, will likely be lower than actual levels; if so, correcting for modeling errors in our emissions estimating procedure would likely increase the estimated cost-effectiveness of the examined vehicle retirement programs. Estimated net benefits also depend on assumptions about the nature of replacement vehicles for those that are scrapped, and the nature of resulting changes in the existing fleet in the area affected by the scrappage program. It is unclear whether the ''vehicle miles lost' by scrapping cars before their normal retirement dates will be made up by increased driving of the remaining fleet or whether these miles will be made up in large part by increased sales and use of new vehicles. Another uncertainty: In a scrappage program confined to limited areas, will the owners of the scrapped cars replace them primarily with cars of more recent vintage, with better fuel economy and lower emissions, or will they ''import' older cars from outside the program area, sharply reducing emission benefits and fuel savings? Table 2 shows the effects on emissions benefits of different technical and policy assumptions.

Some proposals for scrappage programs call for awarding CAFE credits to automakers who scrap their trade-ins on new cars rather than reselling them.[12] Although such plans seek to stimulate new car sales, it may be difficult to realize this goal in practice. Further, if the automakers use the credits to avoid other measures that would raise new car fleet fuel economy, the result of such a program would be

11 This scenario assumes that half of the ''retired'' mileage would be replaced by new cars, and half by the existing fleet. Other assumptions about the nature of the replacement vehicles will change the outcome somewhat but will not shift the cost/benefit ratio above 1.0 (that is, into the "not cost effective' range).

12 S. 2237 proposes to award a CAFE credit in the amount of the difference in fuel economy levels of the new car purchased and the old car traded in, for each transaction when the old car is scrapped.